Light and Lighting

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Road Lighting and Safety

HARD upon the decision of the Minister of Transport to provide flashing light beacons at pedestrian crossings comes the report of the Committee on Road Safety upon the unforgettable bus accident at Gillingham last December. The Committee conclude that the accident had three main features, (i) the inadequacy of the street lighting, (ii) the lack of proper safeguards for the marching cadets, and (iii) the failure of the bus driver to use his headlights. There is no doubt that the accident would not have occurred had there been suitable street lighting, or had the driver used his headlights as prudence would have dictated. The Committee recognize that an adequate standard of street lighting throughout the country is of great importance to road safety. Accordingly, they recommend that the improvement of street lighting should be given special attention and, if necessary, lighting authorities should be given assistance from central funds. Further, drivers should be encouraged to use properly adjusted dipped headlights in badly lighted roads. We hope the Committee's recommendations will be implemented speedily. It is not too much to say that the present lighting of some of our roads is probably more dangerous than useful.

Notes and News

Filament Lamp Development

Though during recent years interest in the development of light sources has been centred mainly on discharge lamps in almost every discussion of the subject, reference has been made sooner or later to the possibilities of increased efficiencies from tungsten lamps. In a recent lecture to the I.E.S. of New South Wales, Dr. Dresler, after referring to the well-known limitations imposed by filament temperature, discussed the possibilities of the use of a heavier filling gas, increase of gas pressure, and a combination of the two. He pointed out that though theoretically some improvement in efficiency was possible by use of these expedients, there were practical difficulties, such as the cost of krypton, the most likely filling to give the desired results, and the costly alterations to machinery, which would make such high-efficiency tungsten lamps rather expensive. It is of interest, however, to review briefly developments in connection with heavier gas fillings and increase of the pressure of the filling within the lamp.

The first gas-filled lamps were made with a nitrogen filling. It was, however, realised that a monatomic gas would be more suitable, and once supplies of argon became commercially available, argon quickly superseded nitrogen as the principal constituent of the gas-filling. The use of fillings other than argon have been suggested by many workers, and krypton found a limited use in certain low-wattage general lighting service lamps in Europe before the war. They have not been reintroduced since the cessation of hostilities, due to the obvious economic factors, krypton being very much more expensive than argon due to its rarity as one of the atmospheric constituents.

High-pressure mercury vapour suggests itself as a filling because of the high atomic weight of mercury, and work has been carried out in this country on the development of very high brightness projection lamps using a filling of high-pressure mercury vapour. The use, however, of krypton, xenon and high-pressure mercury vapour for ordinary gas-filled lamps is impracticable at the present time either on account of cost or for a variety of technical reasons.

With regard to the use of filling pressures greater than atmospheric, it should be noted that the object in all gas-filled lamp manufacture is to work with as high an initial gas pressure as is practically possible. In this case what matters, of course, is the amount of gas within the bulb, and therefore it is a high-filling pressure at ordinary temperatures which is required. The fact that a lamp will develop a pressure considerably in excess of one atmosphere when the lamp is in operation will not result in a materially improved performance if the cold filling pressure is only normal. There are, however, quite serious difficulties and even dangers inherent in the use of a filling pressure greater than that at present generally employed.

Dr. Aldington stated recently in his paper to the British Electrical Power Convention that the tungsten filament lamp must not be regarded as having reached finality in development, although he thought it unlikely that major developments would take place in this field. There is, however, a constant urge to improve the average quality of the tungsten filament general lighting service lamp as instanced by the recent increase in the minimum values of the appropriate B.S. 161.

During the discussion of Dr. Dresler's paper reference was made to some pre-

war experimental work on triple coil filaments. This was a new one on us, but we gather that work in this field carried out in this country indicated that the complications and difficulties which arise from the use of a triple coil are such as to outweigh the advantage resulting from a shortening of the filament and the consequent slight decrease in the gas losses: in other words, their life was very bright but very brief.

The Teaching of Illuminating Engineering

We have often wondered how new recruits are found for the lighting industry. Some firms we know have training schemes by which they take young men and put them through a course in their various departments but this probably applies mainly to the commercial side and does not necessarily provide the first-class engineers which are required. There must be thousands of students passing through the various engineering colleges who never consider the possibility of a career in lighting, finding greater attraction in other branches of engineering. Perhaps it is not thought necessary to attract such people but we would have thought that a sound engineering background would have been a great asset in the lighting industry, where such a wide diversity of interests is involved.

One possible reason why a student finishing his training and considering in which field to specialise does not think of lighting is that he is told little about it during his training. The inclusion of more lighting in electrical engineering courses might not only bring forth more specialists but would be of practical value to many other electrical engineers whose knowledge of lighting is otherwise strictly limited.

We are pleased to note, therefore, that the Education Discussion Circle of the I.E.E. is to discuss the subject of the teaching of illuminating engineering at a meeting to be held at 6 p.m. on November 10 (tea at 5.30). The subject will be introduced by Mr. S. S. Beggs. I.E.S. members are invited to attend.

Architects and Lighting

The election of Mr. Howard Robertson as President of the R.I.B.A. is a great pleasure to us and we offer him our sincere congratulations. Mr. Robertson was one of the first architects to show an active interest in lighting and in 1942 he gave a paper to the I.E.S. on advance planning in lighting reconstruction. Since then he has attained an outstanding position in his profession; he was the R.I.B.A. Royal Gold Medallist in 1949 and was the British member of the international committee of architects responsible for the United Nations headquarters in New York. Though we do not hear much from him these days about lighting we believe that he still maintains his earlier interest in the subject.

Mr. Robertson may not have been the originator of the plea for collaboration between the architect and the lighting engineer but he certainly made a very strong case for it in his paper to the I.E.S. in which he stressed that illumination is a part of architectural design including the design of streets and cities.

The opener of the discussion on this paper was Mr. Grey Wornum, who was awarded the Royal Gold Medal this year. Many other prominent architects also contributed to the discussion. It would seem that 10 years ago the I.E.S. had a closer contact with the architects than it had to-day—flashes such as at the recent Summer Meeting being conspicuous because they are so rare. One wonders why the apparent willingness in 1942 of all concerned to collaborate was not developed as it might have been so that the participation of architects in I.E.S. meetings was the normal thing rather than the exception. There are indications that architects are anxious to learn more about lighting and a useful purpose might be served by making a special effort to help them, possibly by arranging a day or two of special meetings outside the normal I.E.S. programme.

Floodlighting of the chancel of St. John's Roman Catholic Cathedral, Salford.

The Lighting of Office Buildings

The long-awaited report on office lighting* was issued about a month ago. It deals with daylighting and artificial lighting, and the recommendations are supported by a comprehensive survey of existing conditions.

The visual task of an office worker does not usually vary much and the best type of lighting for each type of task should therefore have emerged by a process of trial and error through the years. This has happened in drawing offices and in private offices, but there is still a very wide variety of types of lighting in other specialised offices and in general offices; the two reasons which suggest themselves are first the disinclination to spend money on what may have seemed to be non-productive work and second the absence of any clear guidance as to the best choice of lighting installation. For some years past, added recognition has been given to the value of lighting as an aid to speed and accuracy in the office routine and great improvements have been made in both the quality and quantity of illumination, guided mostly by the experience of managements and the advice of the I.E.S. Code. It is the main purpose of the report on "The Lighting of Office Buildings" to give clear recommendations on the best ways of designing or correcting the lighting arrangements in offices.

Daylight is surprisingly important in the design of an office building, and standards have risen in recent years, so that nearly 60 per cent. of office workers say that they are able to see well for their work by daylight alone. Most offices are therefore arranged to make the best use of the natural light available, and the artificial lighting is generally regarded as being second best, but only few attempts seem to have been made to relate the artificial lighting to the natural lighting. The visual tasks are much the same for office workers in daylight and in artificial light, whether they are reading, writing, typing or talking, but it is only in drawing offices that the artificial lighting is usually arranged to supplement or have the same visual effect as the natural light. This report emphasises the relation between the two forms of lighting and makes recommendations on both, giving minimum levels of sky factor and of artificial illumination and indicating many of the difficulties which need to be considered even though precise solutions cannot be given.

There were four reports on factory lighting before the war, covering the period 1913-1939, and the great advances made in that field were undoubtedly due to those reports and the pressure brought upon managements by the factory inspectors and trade unions and, since 1937, by legislation. In 1944 the D.S.I.R. Lighting Committee issued a report entitled "The Lighting of Buildings," which dealt almost exclusively with dwellings and schools and some of the recommendations in that report have since been implemented by legislation and Government action. The individual householder thinks he knows what he wants without recourse to a departmental report, and therefore the only united action which can be taken about dwellings and schools is by the local and national bodies responsible for the by-laws and regulations governing the buildings. The present report, started by the same Lighting Committee in 1946 and signed in 1950, also seems likely to be followed by some form of legislation, such as that recommended by the Gowers Committee in 1949 that the Factories Act and the Shops Act should be extended to cover office buildings, and the Lighting Committee supports this recommendation. It is therefore of considerable importance to examine the proposals in this report and to

* Post-War Building Studies, No. 30, prepared by the Lighting Committee of the D.S.I.R. Building Research Board. 88 pp., with 8 plates, London, 1952, published by H.M.S.O., price 3s. 6d.

Fig. 1. Direct lighting, with light-coloured decorations.

correct or amplify them where necessary before they have the force of law.

The Development of Office Buildings

Part I of the report deals with the architectural development of office buildings and notes that although lamps and fittings have developed they have had little effect on the design of office buildings. The use of the windowless office is strongly discouraged, but there may be a growing use of supplementary lighting to extend the useful zone of daylight and to permit office blocks to be much deeper than those to which we are accustomed in Britain. If so, the artificial lighting must be much more closely integrated with the original office design than in the past, and must become as much a part of the structure as the windows.

The present position of natural lighting, as revealed by an elaborate survey which covered the whole country, is not very satisfactory and over 20 per cent. of office staff receive inadequate daylight on their work at all times of the day.

In preparing recommendations for future developments, consideration must be given to internal factors, such as the size of the offices which may be large or small, depending on the tenants to whom they are let, the decorations, the furniture, and the type of work which may also vary considerably, and to external factors such as the density of buildings around the site, the degree of insolation and the maintenance of windows and of fittings. The range of variation in these factors is such that the recommendations in this report are only of a general nature.

Natural Lighting

Most offices are lit from one side only, and good daylight is required for at least two rows of desks, that is, for a working depth of about 10 ft., and the Committee recommends that the sky factor be not less than 1 per cent. Drawing offices require special treatment, often including overhead daylighting, and a minimum sky factor of 5 per cent. is recommended. Attention is drawn to several points to be observed in the design of windows, to reduce glare by proper control of the brightness contrasts and by the use of blinds or louvres, to reduce loss of light by dirty glass which may absorb 20 to 30 per cent. unless frequently cleaned, and to use redirecting and diffusing glasses with caution.

Artificial lighting can supplement inadequate daylight with great advantage, and this probably provides a more certain expedient for poorly lit offices than the use of external reflectors or other devices. The colour of the light must blend acceptably with daylight, the fittings should be unobtrusive, and the direction of the principal illumination, and therefore of the shadows,

should be the same as for the daylight. If a room has a well-daylighted zone about 10 ft. wide, it is quite practicable to double the width which seems to be well lit without making the occupants feel that they are working by artificial light.

Artificial Lighting

The report chooses to relate artificial lighting to the precise nature of the work being done, even though daylight cannot be so related and yet offices are largely arranged for daylight, and further suggests that a modern office space should be provided with a "good illumination" over the whole of its usable area, with supplementary local lights for the more difficult tasks. There seems to be some inconsistency in this approach, and perhaps the two years which have elapsed since it was written have enabled the committee to reach some more precise conclusions.

Part III starts with an excellent summary of the factors which determine the severity of the visual task in offices, namely, the size of fine detail, the contrast between detail and background, the sharpness of definition, and the overall brightness (luminance) of the work. This subject is further analysed in an appendix by Mr. H. C. Weston. Reference is made to shiny pencil marks on tinted paper, to blurred carbon copies, to shadows and bright reflections on typewriters, and to the clarity of keyboards and display on calculating machines; the recommendations on these matters are sound common sense. In drawing offices, the visual tasks are more severe, and the simplest way of making them easier is by using a high illumination.

The criterion on which the illumination values are based is adequacy for efficient working, permitting high though not maximum visual efficiency to be attained. The committee suggests that, so long as the types of office work do not change substantially, its recommendations will not require change unless much higher illuminations can be provided economically, and therefore that, once the illumination level has been raised to the recommended figure, any further efforts should be directed towards enhancing the quality of lighting. The illumination values recommended are:—

	lm./ft.^{2}
Bookkeeping, typing, computing machine work, filing and general office work	20
Drawing offices	30
Tracing offices	50
Private offices	15
Inquiry and reception rooms, entrance halls	6
Lavatories	3
Stairs and corridors	1

These figures conform to the current I.E.S. Code. It is, however, noted that more light

Fig. 2. Direct lighting, with no wall reflections.

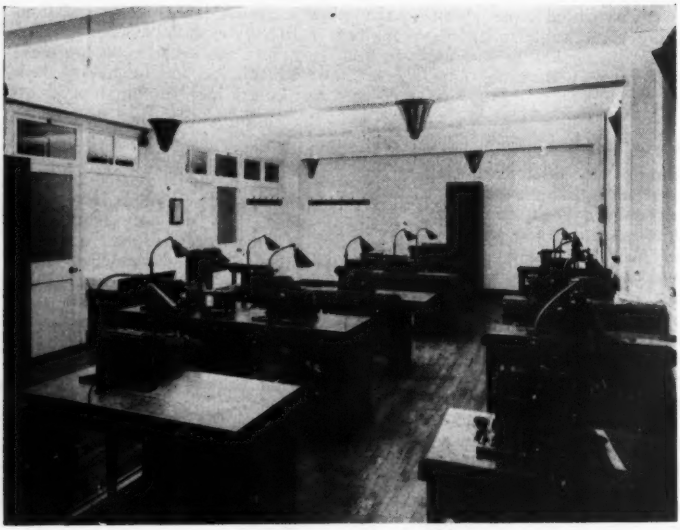


Fig. 3. *Indirect lighting, with supplementary desk lights.*

may be required by persons over 40 years of age and that the adequacy of the illumination would be impaired by glare.

The report contains a useful section on the brightness of the surroundings in terms of "disability glare" and "discomfort glare," and recommends the reduction of hard contrasts whilst retaining those local contrast patterns and graded brightnesses which add to the interest of a field of view. Lighting units which grade from bright central parts to less bright edges and window reveals with light colours are better than uniformly bright sources giving the same amount of light. It follows that the scheme of decoration should be considered as a background both to the light sources and to the immediate visual task, as well as contributing largely to the whole field of view.

Wholly direct or wholly indirect lighting fittings are not recommended because the ceiling is liable to be disproportionately dark or bright, and a semi-direct or general distribution of light is preferred. It may be noted that the higher illumination levels can only be obtained without troublesome glare by using fairly strong directional fittings which give a high proportion of their output at angles lower than about 30 deg. below the horizontal. This is in line with the finding of the survey that nearly 70 per cent. of the offices in the country have direct lighting fittings and under 30 per cent. have general lighting fittings. The fittings should be mounted as high as practicable, avoiding a patchy ceiling and giving a luminance ratio not greater than 30:1 between the fitting and its background. Translucent spheres are liable to be too bright for comfort when used with the high-wattage lamps needed to give the recommended illumination values, and the same is true of unscreened fluorescent lamps; there is a mention of considerable reflected glare under "louverall" ceilings. Visual comfort and visual efficiency are both affected by the brightnesses of the walls, floor and furniture; considerable glare can result from highly polished furniture and machines and from glossy paper, particularly under large lighting fittings giving large patches of reflected light which may be difficult to avoid.

In giving the illumination values tabulated above, several comments are made on details which cannot all be summarised here. These include flexibility in the illumination level by the use of local lights, the avoidance of shadows and specular reflections on machines and on drawing and tracing boards, the use of lighting from left-front on drawing boards and the use of self-illuminated translucent tracing tables, and the need for care in placing the lights for corridors and stairs. There is a recommendation of 10 lm./ft.^{2} for conference and board rooms, which may be used for

examining fine detail on small-scale drawings, and this seems surprisingly low in view of the higher values recommended for general office work and for elderly staff.

Regarding the wiring installation, the committee strongly recommends a permanent uniform general illumination in preference to allowing each tenant to determine the installation for himself. The latter method is, however, more usually adopted in London, although it is likely to lead to wastage, poor workmanship and untidiness. The committee also recommends that the wiring should be designed to provide for incandescent tungsten lamps so that future increases in the illumination values could be met by using fluorescent lamps; this is a little difficult to reconcile with its view that the present recommendations are unlikely to require change. It is, however, interesting that the committee did not differentiate between incandescent and fluorescent lighting to any significant extent; the survey showed that over 75 per cent. of offices in the country have incandescent lighting and, for the most part, the workers seemed satisfied.

The survey of lighting in offices, carried out by the Central Office of Information, is described in an appendix which is comparable in length and in interest with the report itself, but it cannot be fully summarised here. The illumination levels actually measured under artificial light with some daylight in a few instances are, however, specially interesting as a record of present practice :—

Type of office	Representative values of illumination
Drawing	32 lm./ft.^{2}
Typing	11 ,,
Computing	12 ,,
Ledger	9 ,,
General clerical	8 ,,

Appraisal of the Report

Some points of criticism have already appeared in the foregoing summary of the report. In general, it is very good, showing common sense based on sound fundamental data. The particular emphasis on drawing offices indicates one of the places where good factory lighting has spread into the office. One has the impression that the best office lighting is to be found in those concerns which appreciate the value of good lighting for other purposes as in engineering, in business efficiency or in merchandising and that the worst is to be found where the interest is in clerical work only.

The appendices in the report are also of value. Reference has been made to the survey and to the analysis of visual tasks; there are also appendices on the average value of daylight illumination at any hour of the day in any month of the year, on the properties of fluorescent lamps and on the effect of redecoration in some Government offices. There is a good index, which is a real help because the arrangement of the report is difficult at first reading.

One may regret the delay in publishing this report, particularly as it is largely based on evidence submitted to the committee in 1942-44 by the I.E.S. and several kindred associations, with the addition of the survey and of recent reports on the opinions of office staff and likely tenants which were obtained in 1948-49. But the report contains little that is new or striking and the form of the recommendations seems to be more suited to incorporation in legislation than to their use as a code of practice in the development of post-war building or as suggestions for research. It is not really enough to give illumination levels when the levels are as high as in this report; the direction of the light, the diffusion, the risk of glare, the danger of contrasts are all as important as the actual illumination values when these are above 5 or 10 lm./ft.^{2}, but the lighting engineer only gets general guidance from this report. The suggestion that more light will be more adequate runs right through the report, without full warning that more light needs more care in design and without any suggestion of maximum illumination levels for particular kinds of fitting or installation. These qualifications have proved themselves necessary with high-level illuminations given by enclosing globe units and by fluorescent lamps and the fairly precise nature of the various visual tasks in offices should have permitted fairly precise guidance to be given as to the best arrangement for certain typical tasks.

An important point in the report is the welcome emphasis on the need for designing the artificial lighting to supplement daylight and for building the fittings unobtrusively into the structure, from which it would be a short step to the proper design of all the artificial lighting before the plans leave the drawing board.

The illustrations in this article are included as examples of typical office lighting systems and are not taken from the Report.

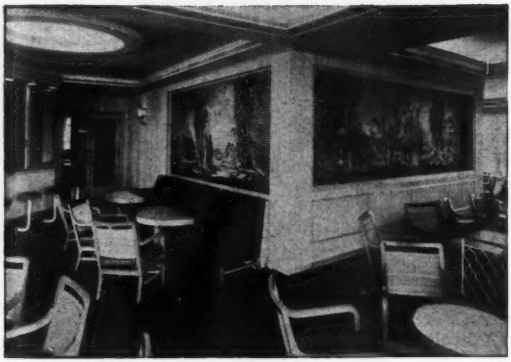
Lighting on the Vera Cruz

Built at the Hoboken (Belgium) yard of the Soc. Anon. John Cockerill, to the order of the Cia Colonial de Navegacao, Lisbon, the passenger liner Vera Cruz is remarkable, not only as the largest and fastest Portuguese liner, but also in having one of the largest cold cathode installations of any vessel afloat. Altogether there is approximately ¼-mile of cold cathode tubing housed in cornices or fittings.

The lighting, provided by the General Electric Company, Limited, does full justice to the furnishings throughout the ship, which has been built as a Portuguese counterpart of British, French, and American passenger liners of the luxury class. A great deal of the lighting uses Osram ivory and amber tubes to give the best possible colour rendering of complexions, dresses and food. It is fitted in many forms—entirely indirect, semi-indirect, direct through glazed cornices, and also in decorative fittings, thus showing its adaptability to the ideas of interior architects.

The main lighting in the 1st class hall "A" Deck is by cold cathode tubes in semi-indirect form, the tubes being fitted behind plastic louvres pointed in an upward direction. This gives a light colour effect on the ceiling from the tubes, while the resultant reflected light makes the most of a large triptych painted by Antonio Soares.

In the 1st class lounge there are a considerable number of small, filament lamp bowls fitted directly into the ceiling and made of Venetian glass but the principal lighting is provided by six very beautiful chandeliers, also in Venetian glass. These have ivory and gold cold cathode tubes, which separately give a touch of colour to the glass but, combined, give a very natural light in the lounge. This room is an excellent example of the successful combination of cold cathode and tungsten lighting.



The lighting in the 2nd class smoke room is again indirect, the cornice being shaped to the curve of the room at the after end, and a very pleasant light is provided by the combination of gold and ivory tubes. Additional interest is given by a number of gilded wall-lanterns with filament lamps.

The lighting in the 2nd class lounge is indirect from a bay on the port and starboard sides and from a central square. Each of these cornices has ivory and gold tubes but the centre square has, in addition, red and blue tubes; and as all the tubes are separately controlled, a variety of colour effects can be provided for the dance floor.

H.M.S. Eagle

No addition to the Fleet in recent years has attracted more general interest than the 36,800-ton aircraft carrier H.M.S. Eagle, the largest carrier in the Royal Navy. The following is a description of the lighting installed on board.

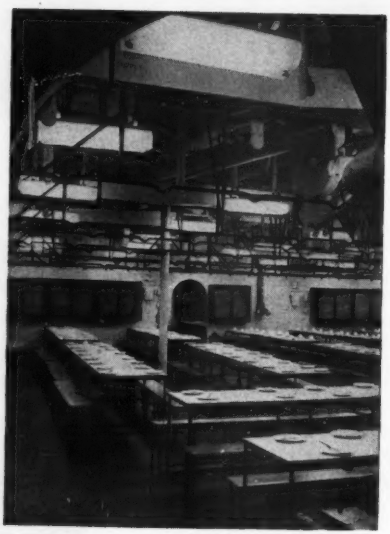
Details made public by the Admiralty show that the ship is able to fly off and land the heaviest and fastest aircraft in the Fleet Air Arm, including jet fighters. Fluorescent lighting has been adopted on a much larger scale in H.M.S. Eagle than in any other ship of the Royal Navy up to the present time. Some 3,000 fluorescent fittings have been installed in living spaces, offices, workshops and elsewhere as a major contribution towards the high standards of efficiency and convenience of living and working conditions that characterise the ship.

A standard design of fluorescent fitting has been adopted, and the whole number has been supplied by three companies working in collaboration, namely, the British Thomson-Houston Co., Ltd., the General Electric Co., Ltd., and Siemens Electric Lamps and Supplies, Ltd.

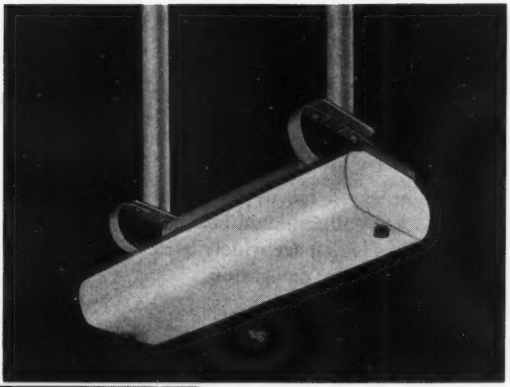
The fluorescent lighting in all spaces except in the wireless rooms, where A.C. is available, operates on the ship's 220-volt D.C. mains. Each fitting contains two 2-ft. 20-watt natural colour lamps connected in series. A ballast resistance in a protective casing, perforated for ventilation, is mounted on top of the fitting.

Because of the D.C. supply, periodical reversal of polarity is necessary to ensure the highest performance. It was a requirement of the design and circuit that the lamps should restrike immediately after the momentary interruption of current during reversal. A conventional thermal starter arrangement was therefore unsuitable because of the time required for the heater to cool sufficiently to allow the contacts to close ready for the restart. A similar delay would be undesirable after a brief interruption of the supply for any other reason. Another consideration was the possibility of low-voltage conditions causing the starter contacts to chatter due to the cooling of the heater, thus causing the lamps to flicker. These difficulties have been overcome by means of a circuit incorporating relay and thermal starter elements embodied in a plug-in relay developed and manufactured for all fittings by Siemens Electric Lamps and Supplies, Ltd., and their associated organisation, Alfred Graham and Co., Ltd. The relay which effects starting of the lamps operates after the thermal element has provided the required time-delay for the heating of the lamp cathodes. A voltage sufficient to cause the lamps to strike is induced by breaking the circuit through the relay coil and no choke is required in the circuit. When the relay has operated, the heater coil and contacts of the thermal element are out of circuit, so that the contacts reclose without short-circuiting the lamps and are ready for restarting immediately an interruption of supply de-energises the relay. The same arrangements prevent flickering of the lamps under low-voltage conditions and stable operation is maintained.

The opal "Perspex" lamp enclosure is



The petty officers' mess deck.



The standard fluorescent fitting used throughout the ship.

View of seamen's mess deck.

secured by two knurled nuts. When removed, access is given to the lamps and the relay unit so that both items can be replaced from below the fitting. Rubber push-on lampholders cushion the lamps against vibration. The fittings were subjected to severe shock tests with the lamps alight before being approved by the Admiralty.

Each fitting is equipped with two standard Admiralty pattern "C" brackets for attachment to the deckhead or to suspension rods. The method of mounting varies in different parts of the ship according to local circumstances. In the living spaces the layout of fittings has had to be planned to clear the hammock bars.

When fittings are installed in spaces where hammocks are slung, individual switches are supported from the deckhead on brackets at a convenient height for occupants of hammocks to control the lights closest to them. Switching from deck level controls the fittings in groups. Separate polarity reversal switches are installed in all spaces where D.C. fluorescent lighting is used and are reversed once every 24 hours.

Operating theatre lighting is by two special fittings designed by Siemens, each containing three 80-watt fluorescent lamps with special dimming control gear.

Illumination levels vary slightly in different parts of the ship, but average 15 lm./ft.^{2}. Lighting supplies are taken from various points on the ship's 220-volt D.C. ring main. Circuit breakers in this distribution system are operated from a low-voltage relay control board supplied by the G.E.C. The control switches are mounted on a mimic diagram of the installation, and the indicator lights are colour-coded according to the circuits they represent.

Maritime Beacons

Some notes on the development of the AGA illuminated beacons and buoys which are widely used as aids to navigation.

by JOHN GRINDROD, B.A.(Com.)

Probably more than any other single contribution has the lighting of beacons and the placing of buoys been responsible for the saving of lives off the coasts and harbours of the world. In the provision of this great boon to navigation it is not surprising that the Swedes, with their own long and rugged coastline, should have been outstanding in their achievement.

It was, indeed, the ingenious devices of Nobel Prizewinner Gustav Dalén that made possible the automatic beacon which became so widely used for this purpose and which made possible the use of acetylene gas in economic quantities. And from these early inventions, many of which are still being installed to-day, have been developed such modern techniques as automatic and remotely controlled electric beacons sited on dangerous groups of small rocks which cannot be approached in rough weather.

Gustav Dalén joined the staff of AGA Svenska AB Gasaccumulator as chief engineer in 1906 and, until his death in 1939, was responsible for its development into a firm of world-wide renown. To-day most of the world's trade routes are swept by lights originating at the AGA works at Stockholm-Lidingö, the use of acetylene gas making this possible in the remotest regions far from any supply of electricity. These installations have been found capable of standing up to the severest stresses and strains that nature could impose. For instance, the light on Muddy Shag Rock, Newfoundland, has been entirely covered with ice but functioned as usual. On the other side of the earth, the Hong Kong beacon and lightbuoys functioned through a 130 m.p.h. typhoon when all the buoys were submerged by violent seas.

The AGA gas system has, as its main cornerstone, the use of a special gas container or cylinder, filled with a porous mass, which makes possible the safe storage of the highly combustible acetylene. This gaseous hydrocarbon gives an intense white light, the spectrum of which is fairly close to that of sunlight. Because of its explosive nature, however, acetylene, even when absorbed in acetone, could not be used safely until Dalén discovered a durable and reliable mass in which an explosive wave could not be propagated. In a cylinder filled with such a mass of 80 per cent. porosity and permeated with acetone, acetylene could be kept and transported at a pressure of 15 atmospheres in complete safety. The cylinder would then contain up to 150 times its own volume of gas.

To make the use of such acetylene economically possible Dalén next invented a flashlight apparatus which could eke out one litre of gas to last for 10,000 flashes. Because of the high intrinsic brilliance of the acetylene flame it is possible in beacon lighting to use comparatively short flashes and by this means the gas consumption can be reduced to one-tenth of that with a fixed light. The flashlight apparatus can be designed to give a single-, double-, or triple-flash at particular time intervals. In the case of a single-flash beacon, for example, the flash may last for 0.3 sec. with an occulting period of 2.7 sec., i.e., a flash of 0.3 sec. every three seconds.

A further step in the construction of automatic beacons was the invention of the sunvalve by means of which the light is automatically extinguished at dawn and relighted at dusk. Its working is based on a central, blackened light-absorbing metal rod surrounded by three gilded, light-reflecting metal rods all parallel to one another. Exposure to the light increases the temperature of the blackened rod over the gilded ones and causes its slight expansion, which, by means of a lever system, operates the gas valve. So effective has this been that no appreciable change in its construction has been

found necessary since it was first used. In conjunction with the flash-light apparatus a saving of 94 per cent. of gas is achieved over fixed light consumption.

The final item which has contributed to the efficient use of AGA beacons for large ocean lighthouses, which require more light power than that provided by an open acetylene flame, has been the Dalén mixer. This apparatus mixes acetylene with air as a result of which incandescent mantles can be used. The mixer also drives a rotary lens system by which the light is concentrated in parallel beams. This not only increases light intensity but gives it a definite character. An automatic mantle exchanger makes it possible for such beacons to be left unattended for any predetermined period up to as much as one year.

This AGA gas system has been found highly suitable for use in lightbuoys, lightships and lighthouses where no electricity supply is available. Buoys manufactured by this firm include those for the open sea, port buoys, buoys for shallow waters, light and whistle buoys, light and bell buoys and every possible combination of these. Here, again, a number of inventions have contributed to efficiency. For instance, the bell buoys, in which the striking mechanism is driven by compressed carbon dioxide, perform their function automatically and well by means of a fog-valve, whose action is based on the fact that human hair expands in humid air and contracts when dry.

Again, in order to maintain a level beam in rough weather, especially when the system was used on lightships, a constant-level table apparatus has been evolved. This prevents the beam from being thrown first down into the water and then up to the sky. Earlier efforts to overcome this consisted of a lenticular apparatus on a pendulum mounted on gimbals, but this was not satisfactory because of the system's self-oscillations due to the force of inertia. In the constant-level apparatus the lens system is mounted on gimbals at its centre of gravity and connected by tension rods to a stabilizing pendulum, the centre of gravity of which coincides with the lightship's centre of motion. The system can be used for either attended or unattended lightships and can be provided with fixed or rotary optical lenses. This levelling apparatus can be used also with an electric lighting system.

A medium-sized AGA buoy when fully equipped weighs about 2.7 tons without anchor chain. The float body is 5 ft. 3 in. in diameter, and it has a detachable counterweight tube which gives it a draught of 11 ft. The upper portion of the float consists of a steel framework which supports the lantern and is so arranged that the beacon is at a height of 10 ft. 6 in. above the surface of the water. A central pocket in the float provides accommodation for three gas accumulators of the type AKB-50, which allow the beacon an unattended period of service of one year, for example, assuming that the burner consumes 15 litres of gas per hour with a steady light, though its flashing arrangement reduces lighting time to one-tenth or one-twelfth of the whole period of service.

The light intensity of approximately 150 candle-power in an 8-ft. drum lens is sufficient for an optical light range of approximately nine nautical miles, given clear weather conditions.

Top marks or frames surrounding the lantern are made in different shapes and sizes according to the size of the buoy and its use, these being many and varied. The smallest type buoy weighs only 75 lb. and can be drawn in and set out by one man in a small boat.

Although many lighthouses still use the AGA gas system, those with access to electricity are often lighted by this medium. Such a beacon, however, requires regular supervision and, in case of faults, power-cuts or failures in supply, it is usually deemed prudent to have a stand-by gas plant which automatically comes into action on failure of the electric light.

Recently, complete installations for remotely controlled beacons have been supplied. These are usually for small rocks and similar sites where access is impracticable in bad weather and where maintenance would be difficult. These are completely and automatically operated from a pilot station some miles away and control may be either by radio or by cable impulse. Power is usually supplied by cable from the mainland, but, to provide against current failure, motor-driven generators are also usually installed in the beacon. These come into operation automatically when faulty supply occurs. All vital parts, too, are usually duplicated. The lighting and extinguishing of the beacon are operated by an astronomical time clock, which automatically alters each day according to the rising and setting of the sun.

In the case of radio-controlled lighthouses, such as the one at Utgrunden, Sweden, controlled by pilot station Garpen, which was the first of this type installed in 1948, the radio equipment consists of two

complete radio stations. In the event of a fault in one, the other station is automatically switched on and a warning signal set in action at Garpen.

Many lighthouses and beacons were destroyed during the war, and, although much reconstruction work has since been accomplished, there still remains a good deal to be done.

One of the biggest jobs undertaken by AGA in this field has been the replacement of the lighthouse system at Hong Kong which was severely damaged. Recent installations there include complete lighthouses for Waglan Island, Lamtong, Green Island and Blackhead. The largest of the units is to be erected on Gap Rock, a small rock island about 28 nautical miles S.S.W. of Hong Kong, and it will serve to mark the entrance to this large centre of East-Asiatic ocean trade. A modern plant is to be installed in which a diesel generator combined with a Nife battery will supply the power for the 1,000-watt lamp and other electric equipment. The beacon will have a rotating lens and the intensity of light will be 1,000,000 candle-power. Lamp failure automatically brings into operation a reserve lamp, while a Dalén light comes into action in the event of current failure. There will also be a four-unit circular sound transmitter.

Two new light and bell buoys have also recently been installed at the entrance to Cape Town harbour, while, of the European deliveries, there have been three complete units for the Belgian lightships, Wandelaan, Westhinder and one reserve lightship, and light and sound installations for the harbour of Nieuport.

It is sad to think that Gustav Dalén, who did so much to light up the navigator's course around the Seven Seas, himself never saw the fruits of his work. Just at the time that his inventions were being recognised throughout the world an explosion during an experiment took away his eyes and he was blind during the last 25 years of his life.

The Lighting of Work Benches

By E. J. WARD

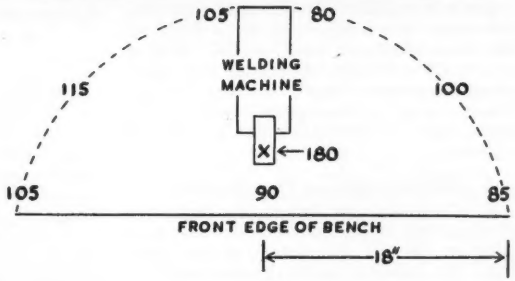
During recent years much has been written concerning standards of lighting for factories and workshops, and many improvements have been made in the levels of artificial illumination both on the working plane and for the general overall lighting of the surrounding areas. It is now an established fact that better illumination and improved "seeing" conditions mean better-quality work and, equally important in these times, an increase in the output from each worker.

But it does not appear to be so readily understood that there should not be a very large difference between the illumination on the object of regard (work-object) and its immediate surroundings if the worker is to receive the maximum benefit from the local illumination. In an effort to give the worker more light upon his work one still sees the machine or bench fitted with local lighting which, coming, as it often does, from concentrated fittings, casts a pool of brilliant light over a limited area whilst leaving the remainder of the immediate surroundings in comparative gloom.

That the eye can rapidly adjust itself over a wide range of brightness is well known, but what is not always remembered is that there is a definite time-lag whilst the eye, suddenly switched from a high brightness level to one which is much lower, readjusts itself. As Lythgoe* pointed out: ". . . the eye works best when the object regarded is surrounded by a field of vision illuminated to the same extent or slightly less than itself."

The point is best illustrated by an actual instance of two operatives, each engaged upon tasks of comparable difficulty and both using spot welding machines. The first of these operators worked at a bench on which the average illumination was little more than 8 lm./ft.^{2}, but to enable her to see the small details of her work a spotlight was fixed to the machine, and this gave approximately 370 lm./ft.^{2} on the working point There was therefore more than a 40:1 difference between the illumination levels at the point where the more difficult part of the work was done and the bench surface on which the tools, trays of components

* "Visual perception under modern conditions." R. L. Lythgoe, M.A., M.D., D.Sc., Trans. Illum. Eng. Soc. (London), 1, 1 (1936).



Showing an operator at work under modern bench lighting. Below, photometer readings are given in lm./ft.² on the working plane (X)

etc., were placed. Although there was more than sufficient light on the task the girl nevertheless sat hunched forward with her face never more than six inches from the welding machine, although at frequent intervals it was necessary for her to look into the comparative gloom that enshrouded the bench and made necessary a change of adaptation before the components in their trays could be seen clearly.

Her colleague was seated nearby at a bench which was illuminated by a source of large area and relatively low brightness. Although this gave less than half the amount of light (156 lm./ft.²) on the area demanding the closest vision, it lighted the bench surface where components and tools were placed to a level of about 80 lm./ft.², the ratio in this case being 2:1. The eyes of this worker were never less than nine inches from the task during the most visually exacting periods, and her posture and attitude generally indicated comfortable and easy seeing conditions. If, therefore, the nature of the work is such that, because of poor contrast between it and its immediate background, or because of the small size of the detail to be seen, a high working illumination is necessary, then the brightness of the immediate surroundings should also be stepped up until a visual comfort balance is reached, e.g., if 100 lm./ft.² are needed on the task, the immediate surrounds should nowhere be less than 10 lm./ft.², and preferably higher (see I.E.S. Code, 1949, Clause 36).

The accompanying figure shows an operator at work under modern bench lighting, whilst below it are given photometer readings in lumens per square foot on the working point (marked X) and on the area immediately surrounding on the bench surface. The higher readings on the left-hand side of the diagram are due to a build-up at these points from an adjoining light source.

The Artificial Illumination of Seedlings

This article, published by kind permission of the Director of the John Innes Horticultural Institution, shows how use is made of artificial lighting in the growth of seedlings.

From October to March there is a serious deficiency of natural light in glasshouses everywhere in the British Isles.

Better husbandry cannot make good this deficiency. When light is seriously deficient, the manufacture of food by the plant is greatly slowed down, no matter how good other conditions may be, and growth becomes weak and retarded. There must be ample light for healthy, rapid and balanced growth.

Artificial Light and Plant Growth

By "growth" we mean the vegetative development of the plant. For this, high intensity light is required. On the other hand, for inducing flower development, low intensities are adequate and the technique of using artificial light is entirely different. The information given in this leaflet refers to vegetative growth only.

The deficiency of natural light in the winter months can very largely be made good by the use of the right amount of artificial light. For example, fluorescent, neon, and high pressure mercury vapour lamps, though emitting light of different colours, are all good light sources for the improvement of plant growth. In other words, it is the intensity (as measured with a light meter) that matters, not the colour. However, the mercury lamp may be chosen as the most suitable for the time being. The lamp unit is compact and therefore offers little obstruction to natural light; it gives light of high intensity; it is of good electrical efficiency; it is a standard product.

Lamp Description

The lamp recommended for seedling illumination is type MA/H, 400-watt, high pressure mercury vapour. It is mounted horizontally in a special horticultural fitting (reflector) and a choke and capacitor are necessary to operate it. Proprietary units are available. The cost of one complete unit is about £16. The life of a lamp is nominally 3,000 hours and the cost of replacement about £3. The life of the other components is many years.

Installing the Lamps

The chief use for artificial illumination is in the propagating house, where a large number of seedlings can be packed under each lamp. The lamps are suspended at a suitable height over the bench, and suitably spaced. Height and spacing depend on the design of the reflector, but 3 to 3½ ft. high from the lamp bulb to bench level, and 4 to 4½ ft. apart, should be satisfactory. At greater heights light intensity rapidly falls off, and at wider spacing the light distribution at bench level becomes irregular along the length of the bench, thereby producing irregular growth of the seedlings. A fall of light intensity across the bench is unavoidable, but this is of little practical importance so long as the area illuminated per lamp does not exceed approximately 4 ft. x 3½ ft. The mean light intensity beneath a single lamp is about 300 ft.c. When a row of lamps is used the mean intensity is increased to about 430 ft.c.

Using the Lamps

To make the most economical use of artificial light, seedlings should be packed pot thick beneath the lamps immediately after pricking out. The number that can be accommodated beneath each lamp depends on the size of the pot and the number of weeks the plants remain beneath the lamps. About 150 tomato plants in 3½-inch pots can be treated per lamp if illumination is

for 3-4 weeks. After that, the plants will be in danger of over-crowding and must therefore be spaced out. Generally, illumination can then be discontinued and the plants moved to as light a position as possible in the house and grown on in the usual way. Another lot of seedlings can then be pricked-out and put under the lamps. In this way up to three lots of plants can be illuminated each winter.

The above remarks apply to seedlings accommodated on a narrow bench 3-4 ft. wide and illuminated by lamps in rectangular-shaped reflectors running lengthwise to the bench. As an alternative, illumination of seedlings on a 6-ft.-wide bench can be accomplished by suspending the lamps transversely across the bench. In this case the height of the lamps should be 3½ ft. and the spacing 4 ft. The area illuminated is then 6 ft. x 4 ft. instead of 4 ft. x 3½ ft., and the number of plants accommodated is 250 instead of 150. But the average intensity for a row of lamps is only 250 ft.c. against 430, hence the *growth* response of the seedlings is proportionately less. It is not yet known whether the *crop* return from 250 plants illuminated at 250 ft.c. would equal that from 150 plants illuminated at 430 ft.c. There is no advantage in pricking-out seedlings and keeping them, say, for a week before putting them under the lamps, on the supposition that the larger week-old seedling makes better use of the light. It does not.

The number of plants per lamp can be further increased by using one set of lamps to illuminate two batches of plants each day. A good way is to suspend the lamp on a strip of curtain rail running lengthwise over the bench. The lamps are used, first over the plants at one end of the bench, and then moved along over the plants at the other end, backwards and forwards every twelve hours. Thus, the lamps are alight continuously and each batch of plants is illuminated, partly during the daytime and partly during the night. Ideally, the lamps should be moved at noon and midnight, but 10 a.m. and 10 p.m.will serve quite well in December. Whatever the daily period of illumination, it is most important with tomatoes to see that they have at least six hours of *unbroken* darkness, or leaf chlorosis and distortion will occur and growth be checked. This does not apply to cucumbers which, apparently, can be illuminated twenty-four hours a day without coming to harm (it is not suggested that illumination for twenty-four hours a day is desirable).

Where ten or more lamps are used to illuminate two large batches of plants a day, a good arrangement is to have all the chokes and capacitors on a hand-barrow which can be moved along with the lamps, thus keeping to a minimum the length of the cables connecting lamps with chokes. For convenience, the cables should be made to "plug-in" to their respective chokes, the lamps being switched-off and the plugs withdrawn while the moving of the lamps is in progress. Because of the danger of the arificial light "spilling over" from one batch of plants to the other, a strip of hessian should be hung between the two batches at night-time. Each batch is then assured of six hours of unbroken darkness.

It should be noted here that lamps may be fitted into nursery routine in several ways. First, seeds may be sown earlier and the lamps used to encourage very early flowering and fruiting. Secondly, seeds may be sown at the usual time and the lamps used to secure moderately early flowering. Thirdly, seed sowing may be delayed and lamps used to bring about flowering at the usual time, thus shortening the propagation period with a consequent saving in labour and fuel.

The financial return from the illumination of crop plants will depend on the latitude of the nursery and the amount of natural light available during the period of illumination. In experiments with maincrop tomatoes at Merton an extra three-quarter lb. of fruit per plant was picked during the first three weeks of fruiting. It seems that the early tomato yield can be increased by 50-70 per cent. and the total yield by 10 per cent. Cucumber responds equally well. Thus, assuming electricity can be bought for about a penny a unit, it would not be impossible to recover the whole of the capital outlay in one year.

Temperature

Mercury lamps give out heat as well as light, and this heat raises the air temperature at plant level by 5-10 deg. F. With a night glasshouse temperature of about 60 deg. F., a rise such as this would result in drawn, spindly growth during the winter months. Since, however, this increase in air temparature is accompanied by an increase in light, growth remains sturdy. Indeed, the extra heat may be turned to advantage. For example, cucumber seedlings of excellent quality can be raised in a glasshouse temperature of no more than 60 deg. F., the "spot-heating" effect of the lamps, along with the extra light, compensating for the lower glasshouse temperature. That is not to

say, however, that still better results would not be obtained with cucumbers when the more normal temperatures are used for propagating this crop.

The interrelation of light and temperature in the propagating house is not only important but intricate. Thus, starting with three-week-old tomatoes, the minimum night temperature should gradually be dropped from 60 deg. F. according to natural light conditions. Within reason, the lower the minimum temperature, the larger become the first and second flower trusses. Artificial light also increases truss size a little, as does the "strength" of the compost, e.g. JIP_2 compared with JIP_1.

Until, however, further knowledge is to hand, growers should not, as a rule, depart from the temperatures they customarily employ, but concentrate on getting balanced root and stem growth.

Later Behaviour of Illuminated Plants

The effect of supplementary artificial illumination is to accelerate the rate of development of the seedlings while they are under the lamps, with the consequence that they flower and fruit earlier than untreated plants. Further, the seedlings start off life sturdier, therefore it is not unreasonable to suppose that their resistance to disease and inclement conditions is greater.

Earlier flowering may sometimes raise difficulties. For example, if tomatoes flower very early in the year, natural light may be so poor as to reduce, or even prevent, fruit setting. Hence the grower must bear this in mind in timing flowering. A fruit-setting hormone is, of course, one solution to the problem, should it arise. With cucumber, no such problem exists. It is amenable in every way to artificial illumination: chlorosis does not occur and pollination is not only unnecessary but undesirable.

Safety Precautions

Whether one or many lamps are used, the greatest care should be taken to ensure that all metal parts, especially the reflectors, are properly earthed. The chokes should be covered with roofing felt, or similar material, to protect them from water. All cables should be robust and heavily insulated.

Acknowledgment

This article is a reprint of a pamphlet, leaflet No. 11, entitled "Artificial Illumination of Seedlings," published by Oliver and Boyd, Ltd., price 9d., and reprinted here by permission of the Director of the John Innes Horticultural Institution.

Personal

Mr. Oliver W. J. Farmer has been appointed manager of lamp and lighting advertising for the B.T.H. Co., Ltd., in succession to Mr. H. E. Goody, who retired at the end of July. Mr. Farmer joined the staff of the Mazda advertising department in December, 1945, after war service in the R.A.F. He was appointed deputy-manager of the department in 1948.

Personnel changes in the Supplies Division of Crompton Parkinson, Ltd., recently announced are as follows: Mr. C. J. Johnson, previously Birmingham branch manager, has been appointed sales supervisor (training) attached to the head sales office in London. His place in Birmingham is taken by Mr. C. Whitaker, previously manager of the Cardiff branch. The new manager at Cardiff is Mr. J. Watson (Registered Lighting Engineer, I.E.S.), who joined the company in 1939 as a lighting engineer and who was assistant branch manager at Manchester.

Mr. W. F. Cassidy, formerly branch manager in Birmingham for Philips Electrical, Ltd., has now been appointed regional manager for the area, which has been extended to include the territory covered by the Nottingham office, where Mr. N. R. Law remains as branch manager.

Trade Literature

J. A. CRABTREE AND CO., LTD.—New illustrated catalogue of accessories and switch gear products. Included are details on new products and changes in standard finishes.

THORN ELECTRICAL INDUSTRIES, LTD.—Handbook of Atlas lighting fittings for tungsten filament lamps, giving illustrated details of comprehensive range. Also catalogue of fluorescent and tungsten lamps, giving prices and other full details.

EDISON SWAN ELECTRIC CO., LTD.—New publication on Ediswan Ensur-a-Lite emergency lighting equipment. Describing applications, systems, specifications, etc.

BRITISH THOMSON-HOUSTON CO., LTD.—Lamp price list, L.910, which serves as a guide to the list price and purchase tax changes which were enforced in June.

EKCO-ENSIGN ELECTRIC, LTD.—Illustrated folder on diffusing glass fittings for use with tungsten lamps.

A publication giving statistics on the production of 4-ft. fluorescent fittings in selected factories in the United States, prepared by the United States Department of Labour, is obtainable in this country from the British Institute of Management, 8, Hill-street, London, W.1, price per copy £1.

A Hen Battery Lighting Scheme

A description of the lighting of a battery house at Wye College, where experiments have proved that, with artificial illumination, winter egg production can almost equal summer level.

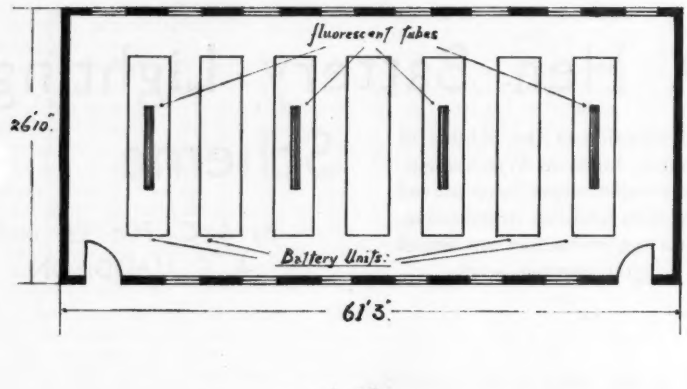
By J. C. FOSTER and A. E. MADDISON

Hens, if kept under normal conditions, will not lay eggs uniformly throughout the year. When the birds are kept out of doors the intensity of their laying usually varies in direct relationship with the length of the daylight hours. We find that they will produce only a few eggs during the winter months when the days are short, and they will begin to come into full lay in the spring as the days get longer. Naturally, this is not a satisfactory state of affairs, as it does lead inevitably to gluts of eggs in the spring and an extreme scarcity during the winter months. In an effort to spread egg production out more evenly over the whole year it is usual nowadays to keep hens intensively, that is, indoors in batteries and deep litters. This means that the hens are not subject to the extremes of the English winter and also it is possible to artificially illuminate the birds during the winter months. The response to this treatment is quite remarkable. The winter egg production very nearly reaches the normal summer level. Thus, as can easily be seen, the total production is increased and it is maintained at a reasonably even level throughout the year. The Ministry of Food actively participate in this campaign to level out production by paying much higher prices to the producer for eggs produced in the winter months. This economic incentive is a very real one, making the use of artificial lighting essential to the large-scale producer to-day.

At Wye College it was decided in 1950 to build a battery house for certain birds that were being used for a somewhat complex breeding scheme. The scheme, whereby the propensities of certain families of birds was being measured in terms of the eggs laid by these families, demanded that the environment into which the birds were being placed should be fairly uniform. Diagrams of the building are shown. It was of standard construction, the walls being made of concrete and the roof of asbestos supported on angle-iron purlins and roof trusses.

Lever Visi-Chick battery units were placed in the house, as can be seen from the diagram. Each unit contained 84 cages, there being three layers, placed one above the other, of 28 cages.

The windows provided gave reasonably uniform lighting during the day, and it was hoped to provide a system of artificial lighting that would also reach this standard of uniformity. Direct lighting from above does, unfortunately, lead to a sharp differential in light intensity between the three layers of cages, those at the bottom being virtually in the dark. It was, therefore, decided to resort to a system of indirect lighting, using fluorescent tubes. Four 8-ft. 120-watt lamps were installed in the battery house in the positions indicated in the diagram. They were suspended from the ceiling so that they hung 8 ft. above the floor, giving them a clearance of approximately 2 ft. above the battery units. In order to give a light cut-off below the horizontal, so that the lighting would be truly indirect, the tubes were placed in wooden trough reflectors. The tubes were situated in the troughs so that their upper surfaces were in the same horizontal plane with the upper edges of the troughs. The tubes were held in this position by means of two spring clips. The troughs were quite simply made of ¾-in. deal, and were painted both inside and outside, the inside being



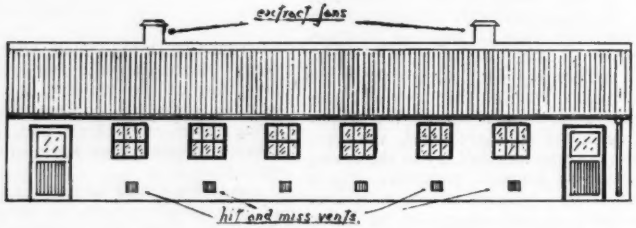


Fig. 1.

finished a flat white. Finally the troughs were rendered quite dustproof (an essential in a hen battery) by the fitting of a lid made by cutting one corrugation from a sheet of "Perspex" and screwing it to the upper edges of the trough.

The supplementary equipment necessary to each tube was built into wooden dustproof boxes with only the starter switch exposed to facilitate its replacement if necessary. The boxes were hung by means of galvanised chains from the purlins immediately above the tubes. Flexible t.r.s. leads were used between the tubes and the boxes and also between the boxes and a standard three-pin, 2-amp. socket. The remainder of the wiring was enclosed in a galvanised steel conduit running from end to end of the upper purlin. Eight three-pin, 2-amp. sockets were fitted at equal distances along this conduit so that a maximum of eight fluorescent tubes could be fitted if they were deemed necessary. At present, as can be seen from the diagram, only four tubes are being used.

The whole of the inside of the battery-house was painted for cleanliness and also for light reflection, two coats of Snowcem being used. Some idea of the light intensities obtained can be gained from the table below. Although these may not be considered to be particularly uniform it must be remembered that they are an improvement over those obtained with many systems to-day and can

(Continued on page 292)

Fig. 2.

REVIEWS OF BOOKS

"Photoelectric Cells and Other Light Sensitive Devices," by P. T. Smith, Percival Marshall and Co., Ltd., London. Price 5s., pp. 78.

This little book sets out to explain how—not why—photoelectric cells work, and how they are used, in language which assumes little beyond natural inquisitiveness and intelligence on the part of the reader. It succeeds really very well. About a dozen pages are devoted to the cells themselves, about 40 to a great variety of their uses including sound reproduction and television, and the remainder to experiments designed to confirm the information conveyed, or whet the appetite for more, or perhaps eliminate the need for it, should the reader not have a healthy respect for the electrical circuits shown in the very clear diagrams.

There is nothing here for the specialist, but for the *bona fide* layman who wants to start at the very beginning this is quite a good introduction. Two things particularly stand in its favour, namely, that it appears to be accurate, and that it wisely eschews analogies reminiscent of a plumber's paradise. The most the reader is asked to consider, by way of explanation, is the effect of throwing stones into a pond. J. S. P.

"Modern Lighting Technique," by H. Hewitt. Edward Arnold and Co., London. pp. 215. *Price* 21*s.*

The main purpose of this book, as the author states in the preface, is to present a study of the technique and equipment used in the general lighting of interiors and in the lighting of streets. Mr. Hewitt has succeeded admirably in achieving this object: the book is, in general, well written and the subject matter is presented in an eminently readable form. The diagrams throughout the book are exceptionally clear and well conceived; this should materially assist the reader.

A few criticisms regarding points of detail should, however, be made. On page 17, following the formal definition of luminous flux, the author quite wrongly introduces the velocity of propagation of radiant energy when referring to the conception of luminous flux as a *time rate of flow* of radiant energy. In the same chapter the author, when dealing with the term "brightness," fails to emphasise the distinction between photometric brightness (luminance) and subjective brightness (luminosity). This omission is, perhaps, not serious from the point of view of the reader with a practical outlook, but for the student of illuminating engineering it is likely to cause confusion. Further, in the table on page 16 the author uses the quantitative term "luminance" as an alternative for both photometric and subjective brightness. In connection with "brightness," the author has also omitted to quote the simple numerical relationship existing, for a perfect diffusing surface, between the units "candela/ft.^{2}" and "foot-lambert."

In chapter seven the section dealing with fluorescence could, with advantage, be extended. There is no reference, for example, to the effect of the wavelength of irradiation on the magnitude of the emitted luminous flux from a fluorescent substance.

Finally, there is some inconsistency on the part of the printer regarding the abbreviation used for "lumen."

In spite of these minor criticisms, Mr. Hewitt's book is a valuable addition to the present limited range of literature on the subject. For the student of illuminating engineering the book will be most useful within its well-defined scope.

E. C. W.

SITUATION VACANT

Stella Lamp Co., Ltd., 37, Oxford-street, London, W.1, invite applications from experienced electric lamp SALESMEN, age around 30. Outside representation vacancies occur in London and Yorkshire territories with excellent prospects which could eventually lead to Branch Management, for men with ability to develop business. Address applications in strict confidence to Managing Director.

SITUATION WANTED

Young man (24), three years' experience industrial lighting, requires change. Preferably position in which commercial lighting experience can be gained. Box No. 836.

Hen Battery Lighting Scheme

(Continued from page 288)

certainly be improved upon within the present system.

Table of Light Intensities
(lm/ft²)

(Averages obtained over all the battery units)

	End	Middle	End
Top row	3.8	4.2	3.8
Middle row	2.9	3.4	3.0
Bottom row	2.1	2.4	2.0

It is usual to give the birds a standard day-length during the winter of 13 or 14 hours. This necessitates the switching on of the tubes at 5 a.m. and off again at daybreak, on at nightfall and off again at 7 p.m. This is achieved in the present installation by means of a time switch.

It must be pointed out that the installation described above is only experimental, but it is considered that the results obtained are most satisfactory. The entire electrical installation was designed and installed by the College Maintenance Department in collaboration with the Professor of Agriculture and the Registrar of the College.

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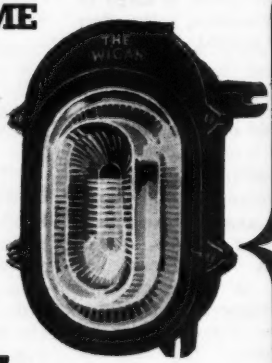

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New Lighting Installations

London Travel Bureau

The illustration below shows part of the offices of Air France, Haymarket, S.W.1. The lighting features an original cold cathode fitting of registered design. It is streamlined in appearance and fitted with luminate glass between the lamps. There are three 20-mm. lamps, two of which are "sunlight" in colour and the centre lamp "fluorescent red." The two colours blend well and produce a bright warm atmosphere. These lamps run at 120 MA and give a general level of illumination of 18-20 lm./ft^2. Another neat fitting is used for lighting the wall map seen on the left. The complete installation, including the design and manufacture of fittings, was by Modern Electric (Installations), Ltd.

Cold cathode lighting in the offices of a London travel bureau.

Fluorescent lighting on one of the jetties at the Shellhaven refinery.

Shellhaven Refinery

Oil tankers from all parts of the world and barges from the waterways of Great Britain docking at the Shell Company's new Shellhaven Oil Refinery for refuelling are receiving a rapid and brighter service as a result of new fluorescent jetty lighting supplied by the B.T.H. Co., Ltd., and installed by Shell engineers.

This is believed to be the first fluorescent lighting installation of its kind, and is part of a scheme to provide better working conditions and maximum production efficiency in the oil refineries of the United Kingdom.

At Shellhaven 11 five-lamp 5-ft. 80-watt industrial flameproof reflector fittings, on specially constructed frames for multi-angle direction, have been mounted on Stanton columns along three jetties of the oil wharves. Lighting intensity is in the region of 17 lm./ft^2.

The tank farm is illuminated by 1,500-watt long-throw projection lamps and 400-watt mercury vapour fittings operated from the pump houses.

Many obstacles had to be surmounted in planning the lighting scheme, including the corrosion of fittings by salt spray. But the greatest difficulty was to provide evenness of light over the jetties while staggering lanterns to avoid the numerous bollards placed at irregular intervals. By careful planning and the use of specially designed equipment these difficulties were overcome.

Retort House Lighting

In the past little specialised attention has been given to the provision of adequate lighting in gasworks retort houses. The construction of a modern horizontal retort installation has now presented the opportunity of providing lighting conditions of the highest efficiency. The effect of lighting in a retort house, however, depends partly on the quality as well as the quantity of light; experience has shown that the blue-green light of mercury lamps minimises the obscurity caused by smoke and steam when a retort is discharged.

For this reason it was decided to install mercury lamps in the new retort house at the Watford Works of the Eastern Gas Board, which came into service recently. The installation, carried out by the Board's staff, was planned by the General Electric Co., Ltd., and comprises 17 "Osram" 250-watt mercury lamps in 14-in. vitreous enamel reflector fittings with dust-proof front glasses. The fittings have heavy duty "Saaflux" tops, which are resistant to corrosive atmospheres.

Six fittings are attached to stanchions at both sides of the building to illuminate the charging and discharging floors of the retort house. The mounting height is 15 ft., and the fittings are at a spacing of 20 ft. A sheet steel box containing the choke and capacitor necessary for operating the lamp

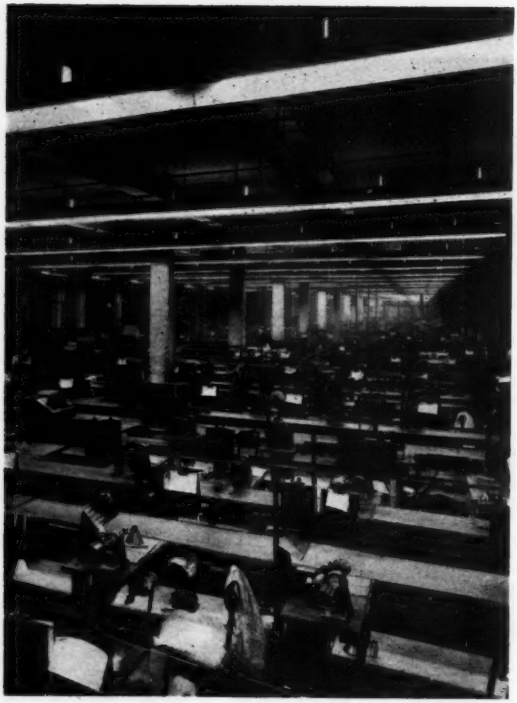
Mercury lighting on the charging floor of the new retort house at the Watford works of the Eastern Gas Board.

is attached to the same stanchion as each fitting.

Two similar fittings are mounted on one end wall of the retort house, and three more are arranged to light the waste heat boilers at a lower level. The new installation has considerably improved working conditions, and maintenance of machinery can now be carried out in many cases without using local lighting.

The need for a high standard of illumination for the Drumming and Beaming of rayon fibre is very well shown by this photograph of an installation using continuous runs of Benjamin Fluroliers.

A Metrovick installation at Larbert Parish Church, Stirlingshire, using rectangular trough reflectors, each with two 100 or 150-watt tungsten lamps and diffusing glass screens.



A Coil Winding Shop

An installation of more than 500 "Atlas" lighting units, each housing two 5-ft. 80-watt lamps, has recently been completed in the coil winding shop of the Plessey Co., Ltd., at Ilford. The total area of the shop is over 30,000 square feet, and the requirement was that the lighting level on the machines should be not less than 45 lm./ft.^{2}, this level being essential since most of the coil winding is with very fine gauge wire.

The photograph shows one of four sections of this shop. The fittings, which are mounted in continuous rows, all incorporate "Atlas" quick-start control, and "double-life" daylight lamps. This is the first step in a major changeover to fluorescent lighting throughout the factory. The contractors were Messrs. John Hearson and Co., Ltd.

Interior of a motor car showroom at Yeovil.

Lighting a Car Showroom

Vincents, the Austin agents in Yeovil, went into business as coachbuilders way back in 1840, and have been controlled by the Vincent family ever since. The showroom, one of the largest in the town, and occupying a corner site in the main street, has now become a shining example of what good lighting can do to reveal, after dark, the fine points of quality cars.

The new lighting installation was carried out recently by Messrs. R. and G. Bowsher, electrical contractors, in accordance with a scheme designed by the lighting department of Crompton Parkinson, Limited, and using Crompton fittings throughout. The main lighting is provided by "Ashford" fluorescent lighting fittings mounted directly on the soffit of the ceiling beams, and spaced out clearly over the width of the area to conform to the general ceiling pattern. With the "Ashford" fitting the two 80-watt lamps are totally enclosed within a one-piece diffuser of fluted opal plastic material and flashed opal ends, giving a comfortable light with high efficiency. With natural lamps the result is a diffused light pleasant to the eye and giving true colour rendering of car finishes. The diffuser is attached to the wiring channel by a simple method which prevents dust from settling inside.

Window lighting is obtained with Crompton reflectors of a type shaped to throw the greatest amount of light in the required direction.

Salford Cathedral

Cathedral lighting sets the illuminating engineer special problems since the congregation's attention should be focused on the altar and its environs. Nave and aisle lighting must be discreet, and yet give adequate light for the reading of service books and hymnaries. In St. John's Roman Catholic Cathedral, illustrated on p. 270, the G.E.C. have achieved all these results by flood-lighting in the chancel and the use of strong tungsten light sources at the level of the capitals in nave, aisles and transepts.

The chancel is illuminated by a battery of 200-watt Gecoray floodlights in the cross-over below the steeple and further 200-watt units behind the pillars in the chancel itself, the general effect being balanced by small indirect flood-lights mounted on the clerestory window embrasures, and directed on the chancel roof.

Six hexagonal black iron lanterns, 18 in. in diameter, suspended from brackets mounted on the walls in the angles formed by the arches, light the nave. The design of lanterns and brackets fits naturally into a Gothic setting. Each lantern is arranged for one 300-watt and four 60-watt lamps, which give ample light for reading in the pews. Similar but smaller lanterns are employed in the side aisles and transept chapels.

The architects were Messrs. Reynolds and Scott and the electrical contractors Messrs. Robert Springer.

POSTSCRIPT

By "Lumeritas"

The April issue of the Australian I.E.S. Review contains an excerpt from an article on "Contrast and Illumination," written by J. R. Cravath and published in *Electrical World* nearly 40 years ago. The passage quoted is as follows:—

"The most comfortable conditions of artificial lighting in practice are likely to be found where violent contrasts of surface brightness within the ordinary range of vision have been eliminated. This does not, as some might infer, by any means necessitate or make advisable a uniform light colour of walls, ceilings and floors and a system of indirect lighting which will uniformly illuminate these surfaces. It does mean, however, that one should seek to eliminate as far as possible sharp contrasts in the surface brightness in the adjacent parts of a room."

"This," comments the *I.E.S. Review*, is just another exposition of the modern 'brightness engineering' approach—a little more up to date than most, perhaps, for it suggests that uniformity of brightness can be taken too far—a view now being expressed by quite a number of eminent British and American lighting engineers." The Australian journal rightly adds that Mr. Cravath's remarks go "to show that the 'brightness engineering' concept is not so very new after all!" This is true, for the concept is equally implicit in passages to be found in issues of *The Illuminating Engineer* (now *Light and Lighting*) published several years before Mr. Cravath's article. For example, in the issue of March, 1910, the control of brightness ratios in the field of view, so as to achieve comfortable lighting, was advocated by Mr. W. R. Cooper in his contribution to a discussion on glare.

The ban on the use of fluorescent lighting in French schools has been a matter for surprise in this country, where it has been thought to be due to a suspicion that fluorescent lighting has deleterious effects. This is, indeed, one of the reasons for the ban, although it appears, from a report of the committee which prepared the Schools Regulations made by the French Ministry of National Education, that the primary reason is that no economic advantage is to be gained by using fluorescent lighting in schools. The fear of deleterious effects upon the eyes is on account of the presence of some ultra-violet radiation in the emission from fluorescent tubes. The amount of this radiation is small—as is well known to many readers of this journal—and I think it is true to say that the best-informed medical and ophthalmological opinion in this country is that it is harmless. The economic argument for tungsten rather than fluorescent lighting in French schools is much sounder than the medical one. Nevertheless, its strength is weakened by the recommendation in the Regulations that preference should be given to semi-indirect lighting and to the use of "daylight" tungsten lamps. Now, the nominal average luminous efficiency of fluorescent lamps is about 35 lumens per watt, that is, about three times the efficiency of ordinary tungsten lamps. This superiority of fluorescent lamps may not be sufficient to offset the additional costs involved for the installation and maintenance of fluorescent lighting in some schools. But the economic picture is substantially different when the alternative to fluorescent lamps is tungsten "daylight" lamps, for the former are about nine times as efficient as the latter.

Extensive use is made of fluorescent lighting on the new American ship United States, which recently made her maiden voyage at record speed. There is, however, a preponderance of tungsten lighting. I had the opportunity of looking over this fine ship on her arrival here, and while much of the lighting I saw was pleasing and suitable, I did not come away with the impression that it was of outstanding excellence. In one of the reception halls of the Ocean Terminal at Southampton I was surprised to find that most of the concealed tubes were flickering badly and persistently. It is a pity that maintenance should not have been better with such an occasion as this impending.

I have just received a copy of a useful publication of the National Physical Laboratory, which defines the units and systems of measurement used in the Photometry, Colorimetry and Radiometry Sections of the Light Division. The units given are those normally employed in reports and certificates issued by the Laboratory. The derivation of the units is described, and attention is drawn to those which are accepted internationally. Another recent publication, obtainable from H.M. Stationery Office, is the long-awaited report on The Lighting of Office Buildings. A previous report, by the same Committee, which dealt with the lighting of dwellings and schools, proved a best-seller. The new report may also have a large circle of readers.

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